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Original article

Determination of antimicrobial and phytochemical compounds of *Jatropha curcas* plant

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ABSTRACT

The aim of this study was to explore the effectiveness of different parts of *J. curcas* plant against some selected human pathogens as antimicrobial agent which are known to cause diseases and to check antioxidant and phytochemicals from different plant sections of *J. curcas*. Plant extracts were analyzed by quantification of antimicrobial and phytochemical compounds. This study reveals that 20% ethanol stem extract of *J. curcas* showed maximum antibacterial activity (40 ± 0.0 mm) against *Klebsiella pneumonia*. Water extract of root of *J. curcas* also inhibited *E. coli* (35.25 ± 0.35 mm). The growth of *K. pneumonia* and *Agrobacterium tumifaciens* were also ceased when ethanol extract of *J. curcas* root applied to check their potential as antimicrobial agent. The results also revealed that fungal species, *Aspergillus niger,* and *Pencillium notatum* noted the maximum antifungal activity in ethanol extract of flower and methanol extract of root (38.5 ± 0.7 mm) and (27.25 ± 0.35 mm) respectively. Phytochemicals and many secondary metabolites were present in *J. curcas* extracts such as alkaloids, steroids, tannins, glycosides, flavonoids, saponins, courmerin, and phenolic compounds. It also showed the highest density of color in the different parts of plant extract of *J. curcas*. Similarly, biochemical primary metabolites were observed at maximum amount of biochemical in different parts *of J. curcas,* and correlated with antimicrobial activity. The study concluded that *J. curcas* has great potential as antibacterial agent and cure various human pathogens.

1. Introduction

Medicinal plants are the sources to cure diseases since earliest times and have been used as a source of drug to treatment of illness. The plant derivative medicines have been extraordinary contribution to human health, and has delivered a source of developing contemporary medicines and drugs compound and developments of new prescriptions (Jain and Tripathi, 1991). Moreover, numerous active complex compounds found in medicinal plants that afford the abundant resource of energetic compound used for food industries, cosmetics and medicinal purpose (Ahmed et al., 2016). *Jatropha curcas* medicinal plant played key role in the convention of several purposes disease counting fungal and bacterial contamination (Khanna and Raison 1986). The generic name of *Jatropha curcas* originates from two Greek words Jar'os means doctor and troph'e means food(Kumar and Sharma 2008). Medicinal plants research in drive led medicine in the use of herbal and widely spread public interest and development (Edeoga et al., 2005; Jang et al., 1988). *J. curcas* L. is satisfying and very useful both in agriculture and economic resources, improvement of new complex and main compounds and phytomedicine development (Mkoma and Mabiki 2012).

Almost 170 known species in which 19 species are phorbal ester of genus *Jatropha* which contain toxic compound phorbol ester and

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related to tribe community Joannesieae and belong to family Euphorbiaceae (Grimm 1999). Leaves of *J. curcas* are enormous and five to seven lobed to pale green colors and hypotomatic of paracytic holes. (Rubiaceous) type (Gupta 1985). Plant has the potential to induce by variations and light/temperature in rain fall. Seed contain oil in rich quantity about 27–40% which can be treated to synthesize a good- quality fuel as a biodiesel fuel which can be used as a standard diesel (Liwangf). *J. curcas* segment of stem reported the following compound Deoxypreussomerins, palmarumycins, CP1, JC1 and JC2 (Ravindranath et al., 2004). Antioxidant properties of stem, root and leaves of *J. curcas* had exhibited antioxidant activity, antioxidant models as DPPH radical, scavenging activity, nitric oxide radical scavenging (Sarker et al., 2020). *J. curcas* in animals exhibited hepatoprotective activity with aflatoxin b1 which increase hepatic carcinoma (Balaji et al., 2009).

J. curcas contains various fats compounds such as saturated, unsaturated, and polysaturated fatty acids which have segment of oil mainly palmitic acid, steric and unsaturated fatty acids consisted linoleic acid and oleic acid (16:0) with 14.1% (18.0) with 6.7%, 18:1) with 47.0% and 18:2 with 31.6% respectively(Akintayo 2004; Ling-yi et al., 1996). Antimetastic and anti-proliferative activity reported that different solvent (Methanolic, ethanolic and water) extracts antimicrobial activity in-vitro that showed activity in various pathogen such as against *S. aureus, P. aeruginosa, E. coli* (Igbinosa et al., 2009). Antidiabetic activity in alloxan induced diabetic and normal rats; anti-inflammatory activity was studied from content of leaves in the ethanolic extract in anti-hyperglycemic effect of 50% (Mishra et al., 2010). The antifungal activity was checked in the ethanolic extract in seed cake sample content seed oil toxicity used against callosobruchis maculates insects, parasites, Dinarnusbaralis (Bhandari and Pillai 2005; Sarker et al., 2019). Various segment comprises bioactive compound that contain maximum phytochemical compounds tannins, phytosterol, glycosides, Phenolic compound, flavonoids, sapogenins and steroidal that exhibits extensive range of medicinal potential of plant (Agbogidi and Eruotor 2012). Phytochemicals also contain different compounds and called primary and secondary compound such as total, sugars, amino acids, protein, and phenolic compound such as terpenoids, and alkaloids (Phull et al., 2020a). It provides definite physiological actions to human bodies because plants have bioactive phytochemicals constituents used for the medicinal purpose (Chehregani and Malayeri 2007).

The plant is rich in many other phytochemicals such as highest amount of *J. curcas* contain alkaloids bioactive compound as *Jatropheae* is present in plant that's why alkaloids called *Jatropheae* is compound that is believed to have an anticancer activity property. The seed produces xylose, vitexn and sovitexin, and curcusones (Osemene et al., 2013). The *J. curcas* seed oil is used for skin ailment, sematic, purgative, and laxative, seed also used as asperiant. *J. curcas* having phorbal ester compound that contain toxicity for that plant can be used for agriculture ailments as natural pesticide (Francis et al., 2001). Moreover, water extract leaves showed insecticidal and fumigating properties which are utilized against bed bug in houses (Mekuria 2013). Therefore, this study intended to determine the antimicrobial properties of *J. curcas* plant against some pathogenic bacterial and fungal species, In addition, screening of some phytochemicals activity of plant extract by spectrophotometric method.

2. Materials and methods

2.1. Collection and preparation of sample

Various parts of *Jatropha curcas* plant were collected (root, seed, stem, leaf, and flower) from surrounding of Institute of Plant Science, University of Sindh, Jamshoro, and was authenticated at the herbarium unit of the Department of Plant Science. The different parts of *Jatropha curcas* were taken and put into polyethylene bag, and brought to Institute of Biotechnology and Genetic Engineering (IBGE) laboratory. Then it has been washed with distilled water to avoid any microbial growth.

2.2. Extraction and preparation of plant extracts

Different parts of *J. curcas* extracts were prepared in solvents and water and left to soak at room temperature (21–22 °C) for 24 h. The extracts were strained through muslin or cheese cloth, centrifuges and store at 4 °C for further experiment. Various biochemical tests like total sugar, reducing sugar, and protein were investigated from prepared extracts along with phytochemical tests such as phenolic compounds, flavonoids, antioxidant and antimicrobial activity.

2.3. Media composition and test organisms

1 g Yeast extract, 1 g NaCl, 4 g agar 100 ml distilled water autoclaved at 121 °C for 15 min under 15 l.b psi were used for activity. The different bacterial species (*Escherichia coli, Klebsiella pneumonia, Agrobacterium tumifaciens, Salmonella typhmimurum, Proteus vulgar* and *Enterobacter*) and fungal species (*Aspergillus niger, Peculium notatum*) were obtained from the Laboratory of Microbiology department, University of Sindh, Pakistan for antimicrobial activity. Sub Culture of these strains was obtained on nutrient agar for 24 h, and dilutions of strains were made in distilled water with a loop full of inoculums.

2.4. Quantification of total antioxidant activity

Antioxidant activity was observed from four solvents of extracts of *Jatropha curcas* plants by different concentration of α-Tocopherol used as a standard by the methodology of Saeedeh et al., 2007.

2.5. Quantification of phytochemicals

Phytochemicals concentration were determined in different part of *Jatropha curcas* plant extracts and calculated by Gallic acid standard graph (Qu et al., 2010). Flavonoids contents were calculated from Quercetin standard curve. Alkaloids, steroids and courmerin contents qualitatively detected by Soni and Sosa (2013) reported method. For the determination of glycoside test and saponins test reported method was used by Rice-Evans et al. (1997). Tannins, Terpenoids and Quinines test were qualitatively checked from plant extracts by reported method (Murray et al., 2012;Vos et al., 2012).

2.6. Quantification of total sugar, reducing sugar and total protein standard

The concentration of total sugar from different parts of *J. curcas* extracts were calculated by glucose standard curve. Reducing Sugar concentration was observed from different extract of *J. curcas*, with various parts/ segments of plant by Dinitrosalicyclic acids [DNS] method reported by Miller (1959). The concentration of Total protein was determined from four segments of solvent *J. curcas* plant species (Lowry et al., 1951). Bovine serum albumin was used as standard curve to calculate the total protien from plant extracts.

2.7. Statistical analysis

The values of the experiment have been presented as the mean ± SD (standard deviation). The hypothesis has been checked by *t*-test. Variances were measured significant at P < 0.05.

3. Results

3.1. Antimicrobial activity from different parts of J. curcas

In present study, in vitro antimicrobial activity from different solvent water, acetone, methanol and ethanol extracts of various parts of *Jatropha curcas* plants such as (roots, seed, stem, leaf, and flower) were checked. The antibacterial activity was carried out in methanol, ethanol, acetone and water extracts against *E. coli*. The maximum activity was noted in root water extract (35.5 ± 3.53 mm), while the minimum activity was found in seed sample (16 ± 1.41) of water extract. In the ethanol extract, the maximum activity was noted in root (27.5 ± 3.53 mm), while the minimum activity was found in seed (12.5 ± 3.53 mm). Against *E. coli*, the maximum activity was obtained in methanol extract of flower (20. ± 0.70 mm), although the minimum activity was obtained in seed (11 ± 1.41 mm), in acetone extract the maximum zone inhibition was found in stem (25 ± 0.353 mm), while the minimum zone was found in flower (14.75 ± 0.70 mm). *Klebsiella pneumonia* was used to check the antibacterial activity of *J. curcas*. The maximum activity was originated in water extract of seed (29 ± 1.41 mm), while the minimum activity was distinguished in leaf (11.5 ± 0.7 0 mm), In the ethanol extract, the highest activity was obtained in stem (40 ± 2.12) whereas the lowest activity was measured in seed (28 ± 1.41), In the methanol extract, the maximum activity was showed in flower (26.5 ± 1.0 mm), although the minimum activity was found in seed (17 0.5 ± 0.5 mm).In acetone extracts, the maximum inhibition zone was found in flower (32 ± 1.41), while the minimum zone of inhibition was noted in root (8 ± 0.00) respectively. *Agrobacterium tumifaciens,* the maximum activity was found in water extracts of root (25 ± 2.12 mm), although the lowest result was noted in stem (20 ± 2.12 mm), but in ethanol extract the maximum activity was observed in seed (29.5 ± 0.5 mm), while the minimum activity was found in leaf (19 ± 1.41). In methanol extract the highest activity in stem (28 ± 0.0), while the lowest activity was found in root (16.5 ± 0.7 0). In the acetone extracts, the maximum inhibition zone was measured in root (19 ± 0.70 mm), while the minimum zone was found in stem (11 ± 1.41 mm) [Table 1].

The different parts of *J. curcas* extract were used as antibacterial agents to cease the growth of *Salmonella typhmimurum*, water extract of flower disclosed highest zone of inhibition (21.5 ± 2.12 mm), while lowest activity was examined in seed samples (11 ± 1.41 mm). The ethanol root extract had maximum activity that was exhibited 25.5 ± 0.707 mm, although the minimum result was studied in stem (21.5 ± 2.12 mm). Similarly, methanol extract of seed was shown the highest inhibition zone (23.5 ± 07.07 mm), while the lowest activity was noted in methanolic extract of flower (9 ± 1.41 mm). Furthermore, acetone extract of flower also ceased the growth of *Salmonella typhmimurum* and exhibited inhibition zone (17. ± 1.41 mm), whereas the acetone extract of stem inhibited the growth of same bacteria but quite low in comparison to others (5 ± 0.0 mm). Ethanol, acetone root extracts which didn't inhibit the growth of *Proteus vulgaris* and shown negative results. However, highest results of growth inhibition were noted as acetone stem (25.5 ± 1.41 mm) and methanolic root extracts (25 ± 0.70 mm), water extract of seed and ethanol extract of flower (24 ± 2.82) and (24 ± 1.41) respectively. The lowest zone of inhibition was found in seed (10.5 ± 0.70 mm) than others. The antibacterial activity, the growth of *Enterobacter* ceased and fruitful results of different parts of plant was found in ethanol extracts seed, leaf and flower, 25.5 ± 0.707 mm; 24 ± 1.41 mm, 23 ± 2.12 mm respectively. Methanolic extracts of root 24 ± 1.41 mm while in leaf and flower, but same results were found in water and acetone extracts of flower and seed 24 ± 1.41 mm. However, some parts of *J. curcas* extracts were shown no any potential (Negative) against *Enterobacter* when extracts were used to check their antibacterial activity such as water and methanol stem extracts as well as Acetone leaf and root extracts [Table 2].

3.2. Antifungal activity of different extracts of J. curcas

It was also observed *J. curcas* plant exhibited not only excellent antibacterial agent as well as their different parts also strongly inhibited the growth of two tested fungal species *Aspergillus niger* and *Penicillin notatum* and found best inhibitor of the growth of fungus or best antifungal agent as exhibited in Table 3; The maximum and minimum antifungal activity of various parts of *J. curcas* was measured as in water stem extract maximum (30.5 ± 0.70), while minimum activity was showed in leaf (15 ± 0.0 mm) against *A. niger*.In the ethanol extract, highest activity was found in seed (38 ± 1.41 mm), whereas minimum activity was noted in root (32.5 ± 0.70 mm) respectively. Furthermore, in methanol extracts, the highest antifungal activity was observed in seed (25 ± 0.0 mm), while the lowest activity was shown in root (10 ± 0.0 mm).In acetone extracts, however, the maximum inhibition zone observed in stem (35.5 ± 0.70 mm), while minimum inhibition zone was found in leaf (13 ± 0.28 mm). The highest antifungal activity was

Table 1
Antibacterial activity of different extracts of *J. curcas* against different species of bacteria.

Bacterial Species	Extract	Water	Ethanol	Methanol	Acetone
E. coli	Seed	16 ± 1.41	12.5 ± 3.53	11 ± 1.41	Negative
	Stem	27.75 ± 0.35	12.5 ± 3.53	14 ± 1.41	25. ± 03.53
	leaf	24 ± 1.41	24 ± 1.41	17.5 ± 0.70	Negative
	Flower	31.5 ± 2.12	20 ± 0.07	20.5 ± 0.70	14.75 ± 0.70
	Root	35.5 ± 3.53	27.5 ± 3.53	17 ± 2.12	17 ± 2.12
Klesibella pneumonia	Seed	29 ± 1.41	28 ± 1.41	17.5 ± 0.5	29 ± 1.41
	Stem	15.5 ± 0.70	40 ± 0.2.12	19.5 ± 0.5	15.5 ± 1.41
	Leaf	11.5 ± 0.70	Negative	21.5 ± 1.5	11.5 ± 0.70
	Flower	19.5 ± 0.70	Negative	26.5 ± 1.0	32 ± 1.41
	Root	17.5 ± 1.41	30 ± 0.70	16.5 ± 0.5	8 ± 00
Agrobacterium tumifaciens	Seed	Negative	29.5 ± 0.5	26.27 ± 0.5	13.5 ± 2.12
	Stem	20 ± 2.12	25.5 ± 2.09	28 ± 0.0	11 ± 1.41
	Leaf	Negative	19 ± 1.41	26.5 ± 0.707	13 ± 1.41
	Flower	Negative	23.5 ± 1.41	19.5 ± 0.707	17.5 ± 0.70
	Root	25 ± 2.12	19.5 ± 0.70	16.5 ± 0.70	19 ± 0.70

Table 2
Antibacterial activity of different extracts of *J. curcas* against different species of bacteria.

Bacterial Species	Extract	Water	Ethanol	Methanol	Acetone
Salmonella typhmimurum	Seed	11 ± 1.41	21.5 ± 2.12	23.5 ± 0.7.0	Negative
	Stem	Negative	22 ± 1.41	18.5 ± 0.70	5. ± 0.0
	Flower	Negative	24.5 ± 2.12	9 ± 1.41	Negative
	Flower	21.5 ± 2.12	24 ± 1.41	22.5 ± 0.70	17 ± 1.41
	Root	13 ± 1.41	25.5 ± 0.70	13.5 ± 2.12	Negative
Proteus Vulgar	Seed	24 ± 2.82	Negative	Negative	10.5 ± 0.70
	Stem	17 ± 1.41	Negative	23 ± 1.41	25.5 ± 1.41
	Leaf	16 ± 1.41	16 ± 1.41	24 ± 1.41	18.5 ± 0.70
	Flower	20.5 ± 2.12	24 ± 1.41	22 ± 2.82	22 ± 0.70
	Root	Negative	Negative	25 ± 0.70	Negative
Enterobacter	Seed	19 ± 1.41	25.5 ± 0.70	13.5 ± 2.12	24 ± 1.41
	Stem	Negative	13.5 ± 2.12	Negative	18.5 ± 2.12
	Leaf	20 ± 1.41	24 ± 1.41	20 ± 1.41	Negative
	Flower	24 ± 1.41	23 ± 2.12	20 ± 2.82	14. ± 1.41
	Root	20 ± 2.82	21 ± 1.41	24 ± 1.41	Negative

Table 3
Antifungal activity of different extracts of *J. curcas* against different fungal species.

Fungal Species	Extract	Water	Ethanol	Methanol	Acetone
Aspergillus niger	Seed	20 ± 00	38 ± 1.41	25 ± 0.0	29.5 ± 0.70
	Stem	30.5 ± 0.70	37.5 ± 2.12	28.5 ± 0.0	35.5 ± 0.70
	Leaf	15 ± 0.0	35 ± 0.0	15 ± 1.41	13 ± 0.282
	Flower	25. ± 1.41	33.5 ± 0.70	12.5 ± 0.7	24.5 ± 2.12
	Root	30 ± 2.82	32.5 ± 0.70	10 ± 0.0	35 ± 0.0
Pencillium notatum	Seed	19.5 ± 0.7	20.5 ± 0.77	20.5 ± 2.12	21.75 ± 0.35
	Stem	25.5 ± 0.7	19 ± 0.42	22.75 ± 0.35	23.5 ± 0.70
	Leaf	14 ± 2.82	14 ± 2.82	23.5 ± 0.35	22 ± 2.22
	Flower	14.5 ± 0.7	15.5 ± 0.70	25.5 ± 0.6	24.5 ± 0.35
	Root	20 ± 0.0	25 ± 1.41	27.25 ± 0.3	26 ± 0.56

observed in stem (25.5 ± 0.7 mm) in water extract of *P. encillium notatum*, while lowest activity was found in leaf (14 ± 2.82 mm). Maximum activity was exhibited against various sample of *P. notatum* in the ethanol extract in root (25 ± 1.41 mm), while minimum activity was noted in leaf (14 ± 2.82 mm).Similarly, methanol and acetone extracts, highest activity was observed in both extracts in root (27.25 ± 0.6 mm), and (26. ± 0.56 mm) respectively. Whereas, the lowest inhibition zone was found in methanol and acetone extracts of seed (20.5 ± 2.12 mm) and (21.75 ± 0.35) respectively. The acetone extracts the maximum exhibited inhibition zone was checked in root (26 ± 0.56 mm), while minimum inhibition zone was found in seed (21.75 ± 0.35 mm) [Table 3].

Antioxidant activity of different parts (seed, stem, root, and flower) of *J. curcas* was determined. According to the result as investigated in Fig. 1, water seed extracts showed maximum amount of antioxidant (2.01 mg /ml) although the minimum quantity was obtained in ethanol extract 0.083 mg /ml. Acetone Stem extract exhibited the highest quantity of antioxidant activity 1.95 mg/ml while the lowest amount of the antioxidant was found in ethanolic stem extract 0.100 mg/ml. Furthermore, the maximum amount of antioxidant was also obtained from acetone leaf extract, although the minimum quantity was found in ethanol solvent (0.222 mg/ml). In flower extract, the highest amount (1.86 mg/ml) was found in acetone, although lowest quantity of antioxidant

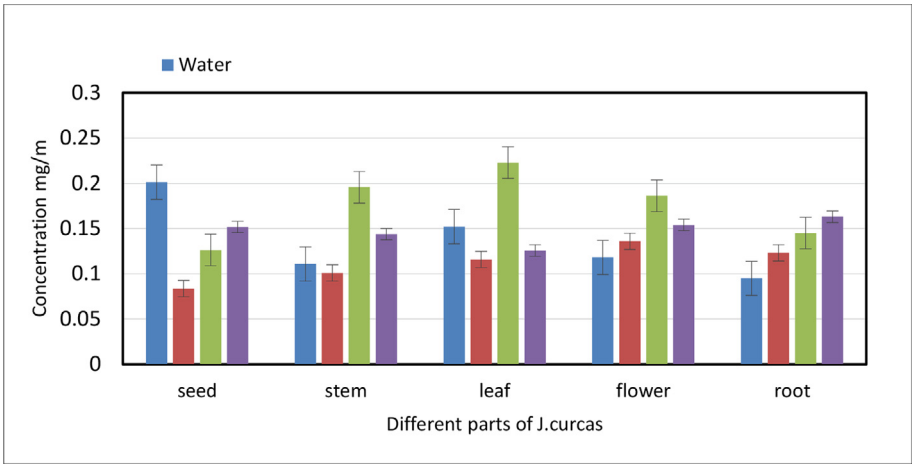

Fig. 1. Quantification of Antioxidant of different extract of *J. curcas*.

was obtained in ethanol (1.18 mg/ml).The maximum amount of antioxidant was observed in root extract in methanol solvent (0.163 mg/ml), while the minimum quantity of antioxidant was noted in water solvent (0.094 mg/ml) in root extract [Fig. 1].

Total phenolic compound was quantified from various fragments of *J. curcas* in different solvent, such as water, ethanol, methanol and acetone as reported in Fig. 2. Total phenolic compounds were highly estimated in water extracts of stem, root, leaf, seed and flower as 4.70, 3.78, 3.31, 2.80 and 2.72 mg/ml. However, solvent extracts of different parts of *J. curcas* also shown significant amount of phenolic compound but water extract found good result in comparison to solvent extracts. Furthermore, the least concentration of phenolic compound 1.32 mg/ml was noted in acetone extract of flower than other parts of *J. curcas* [Fig. 2].

Quantification of the total flavonoid in various parts of *J. curcas* was studied as shown in Fig. 3; the maximum amount of flavonoids was found in seed extracts of methanol (0.359 mg/ml), while the minimum quantity was found in ethanol solvent (0.029 mg/ml). However, the most fascinated result of flavonoid was found acetone stem extract in comparison to other parts of *J. curcas* extracts (0.054 mg/ml), while the lowest quantity of flavonoid was obtained in stem of water extract (0.029 mg/ml). Furthermore, leaf ethanol extract and other parts of *J. curcas* plants also exhibited the fruitful amount of flavonoid (0.038 mg/ml) whereas, the minimum quantity was 0.016 mg/ml in water extract of leaf. The highest result was examined in flower segment (0.049 mg/ml) in acetone but the lowest amount of flavonoid was obtained in methanol (0.033 mg/ml).Similarly, the maximum amount was noted in acetone (0.033 mg/ml), while minimum amount was observed in methanol solvent (0.016 mg/ml) of root extract [Fig. 3].

Tannin was quantified from different segment of *J. curcas* plant as depicted in Fig. 4, the highest range was estimated 0.328 mg/ml in seed water extract than other J. curcas parts extracts. Whilst, leaf, flower and root extract also showed the significant quantity of tannin in water, methanol, and also water extracts as 0.308 mg/ml, 0.315 mg/ml and 0.293 mg/ml respectively. Similarly, the highest amount of tannin was observed in methanol (0.229 mg/ml) in stem extract, while the minimum result was found in acetone solvent (0.179 mg/ml) and methanol solvent (0.168 mg/ml).The lowest quantity was also noted in acetone leaf extract (0.145 mg/ml) and methanol seed extract (0.140 mg/ml) [Fig. 4].

3.3. Determination of qualitative test of various segment of Jatropha curcas plant

The alkaloids were determined through the addition of chemicals in different parts of *J. curcas* extracts. The reddish-brown colored precipitate was appeared in the different fragment (seed, leaf, root, flower, and stem) in various solvents (Methanol, ethanol, acetone, and water). The highest color of density (++++) was appeared in water, methanol, acetone seed and ethanol leaves extracts. The lowest (+) color was produced in flower water, ethanol as well as root methanol and stem acetone extracts of *J. curcas* than other extracts also competent appeared positive results. The appearance of color indicated the presence of alkaloid in various parts of *J. curcas.* Cardiac glycosides were determined through the chemical in extracts solution. A brown color ring was appeared between the solutions that indicated the presence of cardiac glycosides. The highest concentration (++++) of cardiac glycoside qualitative detected in ethanol seed, leaf and flower of *J. curcas* extracts, as well as the same highest active compound also noted in acetone seed, stem and water stem and flower respectively. Furthermore, only one part (root) of *J. curcas* water extract exhibited very low concentration (+) of cardiac glycoside in comparison to other parts of the plant extracts. Other parts of *J. curcas* also shown moderate density of cardiac glycoside. Flavonoids were examined qualitatively through the reported method. To detect flavonoids, the chemicals were added in the extracts of various parts of *J. curcas* after addition of the chemicals in sample, resulting yellow precipitate appeared that was denoted the presence of flavonoids (Phull et al., 2020b). The active compound flavonoid was found high or moderate in all parts except one part (root acetone extract) in which the flavonoid was present in very low amount of the under investigated plant extracts. However, all of them have the highest amount of flavonoids was examined qualitatively in root methanol, seed ethanol, acetone and water stem, leaf extracts as well as flower water, ethanol, acetone extracts of *J. curcas* [Table 4].

Saponins test was performed from different parts of *J. curcas* extracts through reported colour reaction method. After the addition of chemicals in extracts of *J. curcas* in different segments presence stable form that indicated the presence of saponins qualitatively. All parts of extracts exhibited the highly fruitful results, high (++++), moderate (+++) or low (++) but saponins was noted in very low quantity (+) only in methanolic seed extract of

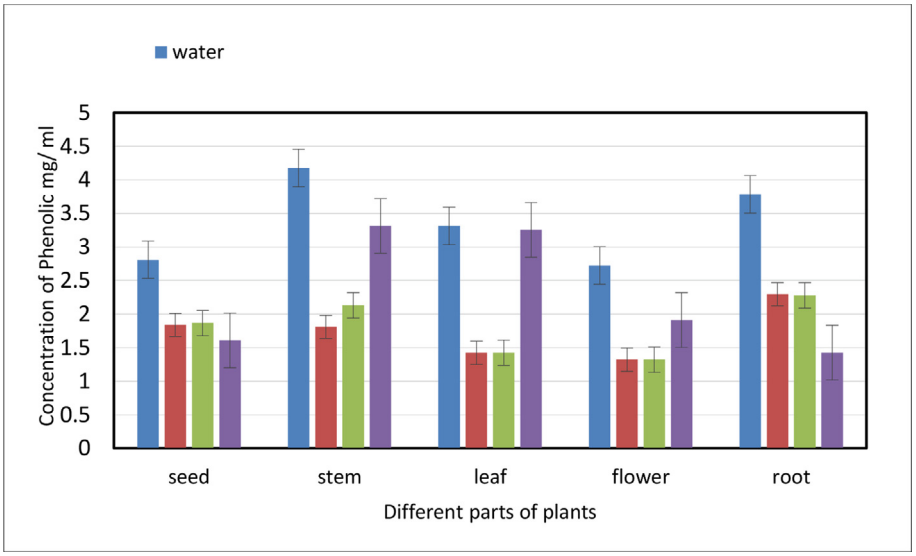

Fig. 2. Quantification of total Phenolic compound of various extract of *J. curcas.*

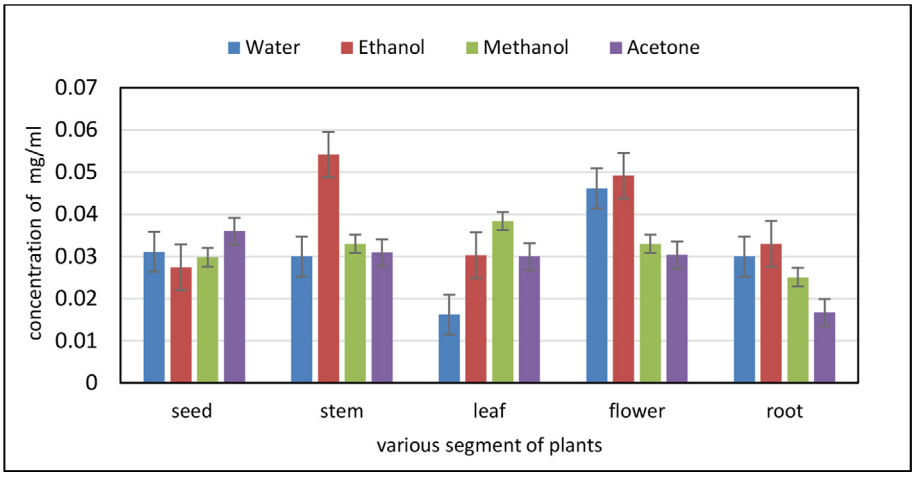

Fig. 3. Quantification of total Flavonoids of different content of *J. curcas*.

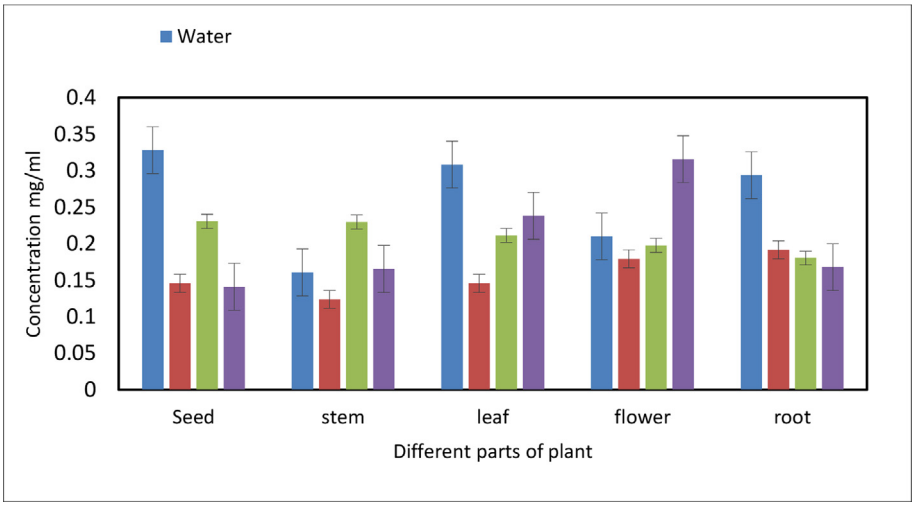

Fig. 4. Quantification of Tannins of different segment of *J. curcas*.

Table 4
Qualitative analysis of different compounds in different Extracts of *J. curcas*.

Phytochemicals	Extract	Water	Ethanol	Methanol	Acetone
Alkaloids	Root	++++	++	+	+++
	Seed	++++	++++	++++	+++
	Stem	++	+++	+++	+
	Leaf	+++	++++	++++	++++
	Flower	+	+	++	++
Cardiac glycosides	Root	+	+++	+++	++
	Seed	++	++++	++	++++
	Stem	++++	++	++	++++
	Leaf	+++	++++	++++	++
	Flower	++++	++++	+++	+++
Flavonoids	Root	+++	++	++++	+
	Seed	++	++++	+++	++++
	Stem	++++	++	++	++
	Leaf	++++	+++	+++	+++
	Flower	++++	++++	++	++++

Note: High density (++++), moderate concentration (+++), low concentration (++), very low (+).

J. curcas in comparison to other parts of the plants extracts. Steroids were investigated from different parts of *J. curcas* extracts when chemical reagent was incorporated in the extracts sample, and resulting violet to blue or green colour produced which specified the presence of steroids. The highest color of density was notified in water seed, stem, leaf; ethanolic extracts of seed, leaf, root as well as methanolic extract of stem, root and acetone extracts of flower and stem correspondingly. Although other parts of *J. cur-*

cas extracts also gave good response in term of moderate (+++) or low (++) density of steroid during the reaction qualitatively but lowest color density was appeared in stem ethanol extract than other parts of the plant. The successful results of tannin were obtained from different parts of *J. curcas* extracts by using colour reaction method qualitatively as summarized in Table 5. According to the data, it was observed that each parts of *J. curcas* contained specific concentration of tannins which was proved by development of greenish colored during the reaction qualitatively. The appearance of color density proved the presence of tannins in high, moderate, low amount as compared to ethanolic extract of root which showed lowest (+) color of intensity [Table 5].

Different segments of *J. curcas* extracts exhibited excellent results of Terpenoids when chemical reagent was added in the sample resulting reddish brown colour appeared which confirmed the high, moderate, low amount of Terpenoids during the qualitative detection using colour reaction method. Quinone is plant secondary metabolite organic compounds which is proton and electro carrier. The maximum color density was observed of seed in water and ethanol extract, Stem in Acetone, leaf of water, ethanol, flower in water, acetone (++++), and also root extract, in all extracts except acetone, which shown moderate result on other hand also stem, leaf in methanol, flower, root, in acetone checked moderate result (+++) although lowest color was appeared in methanol of seed, stem, in ethanol and methanol extracts (+). All segments showed formation of red color that indicated presence of quinines in different extracts. Coumarin is fragment of organic chemical substance belongs to chemical class of benzopyrone although it may also belong to a subclass of lactain. It is colorless crystalline naturally occurring compound in numerous plants (Raza et al., 2017). Courmerin was present in all extracts and parts of *J. curcas* appearance of yellow color that indicated presence of courmerin the highest color of intensity was seen in ethanol root, stem in methanol while in leaf highest courmerin all three extract except one extract in methanol which was moderate and also flower extract shown maximum (++++) result in all extracts. However, during the reaction, colour was developed moderate (+++) in root, leaf in methanol, seed in water, ethanol, acetone, stem of ethanol and also low in root acetone and stem water (+) extracts of *J. curcas* [Table 6].

3.4. Quantification of total sugar in the different parts of J. curcas

The total sugar was quantified from methanol, ethanol, acetone and water extracts of *J. curcas,* the results are summarized in Fig. 5. The maximum concentration of total sugar was found in flower, stem, seed, leaf, and root in different extracts as in ethanol (2.47 mg /mL), in acetone (2.47 mg /mL), also acetone (2.38 mg/ml), of ethanol (2.04 mg/mL), in water of root (1.88 mg/ml) respectively in comparison to other parts of the plants extracts. Although, lowest amount of total sugar was obtained from root (1.84 mg/ml) in methanol, leaf ethanol extracts (1.71 mg/mL). While seed and root acetone extracts have shown similar result (1.25 mg/m) and leaf acetone extract contained lowest amount of total sugar 0.96 mg/ml than other parts of tested plant extracts.

3.5. Quantification of reducing sugar in the different segment of J. curcas

Reducing sugar was observed quantitatively from various parts of *J. curcas* extracts as depicted in Fig. 6. It was noted that the higher concentration of reducing sugar was obtained from water extract of seed in water 0.577 mg/ml, ethanolic stem extract 0.53 mg/ml when compared with other parts of *J. curcas*. However, very impressed but moderate amount of reducing sugar also detected in other parts of *J. curcas* extracts sequentially as methanol seed and stem 0.429 mg/mL, 0.42 mg/ml), leaf in water 0.41 mg/ml correspondingly. Furthermore, it measured lowest quantity of reducing sugar in comparison to other parts of the plant as methanolic root and flower extract 0.395 mg/ml, 0.311 mg/ml, but least amount of reducing sugar was also determined in root acetone extract 0.233 mg/ml, in flower extract 0.230 mg/mL and leaf ethanolic extract 0.20 mg/mL respectively.

3.6. Quantification of total protein in various segments of J. curcas

The different parts of *J. curcas* extracts were also analyzed to measure total protein contents by reported method. All parts of under investigated plant extracts exhibited rich amount of protein (Fig. 7). However, the first three excellent quantities were estimated in acetone extracts of stem, root and leaf (1.10 mg/ml, 1.01 mg/ml, 0.958 mg/ml) respectively. Similarly, minimum quantity of different parts of *J. curcas* was also correlate to each other, it was noted that minimum range of total protein as in methanolic extracts of root, flower and leaf 0.350 mg/ml, 0.317 mg/ml, 0.315 mg/ml whereas the minimum quantity was also found in water extracts of seed and stem 0.335 mg/ml, 0.225 mg/ml correspondingly. Furthermore, acetone and ethanolic seed extracts also shown maximum amount of protein 0.920 mg/ml and 0.851 mg/ml in flower but slightly low in comparison to stem, root and leaf acetone extracts whilst, slightly high than not only methanolic

Table 5
Qualitative analysis of different compounds in different Extracts of *J. curcas.*

Phytochemicals	Extract	Water	Ethanol	Methanol	Acetone
Saponins	Seed	++++	++++	+	++++
	Stem	+++	++++	+++	++++
	Leaf	++++	+++	+++	++++
	Flower	++++	++	++++	+++
	Root	+++	++++	++++	++
Steroids	Seed	++++	++++	+++	+++
	Stem	++++	+	++++	++++
	Leaf	++++	++++	++	+++
	Flower	+++	+++	+++	++++
	Root	++	++++	++++	++
Tannins	Seed	+++	++++	++++	++++
	Stem	++++	+++	++	++
	Leaf	++++	++++	+++	+++
	Flower	++	++	++	++++
	Root	++++	+	++++	++++

Note: High density (++++), moderate concentration (+++), low concentration (++), very low (+).

Table 6
Qualitative analysis of different compounds in different extracts of *J. curcas*.

Phytochemicals	Extract	Water	Ethanol	Methanol	Acetone
Terpenoids	Seed	+++	++++	++	++
	Stem	++++	+++	++++	++++
	Leaf	++++	++++	++++	++++
	Flower	++++	++	+++	+++
	Root	++	++++	++++	++
Quinones	Seed	++++	++++	+	++
	Stem	++	+	+++	++++
	Leaf	++++	++++	++	+++
	Flower	++++	++	+++	++++
	Root	++++	++++	++++	+++
Courmerin	Seed	+++	+++	++	+++
	Stem	+	+++	++++	++
	Leaf	++++	++++	+++	++++
	Flower	++++	++++	++++	++++
	Root	++	++++	+++	+

Note: high density (++++), moderate concentration (+++), low concentration (++), Very low (+).

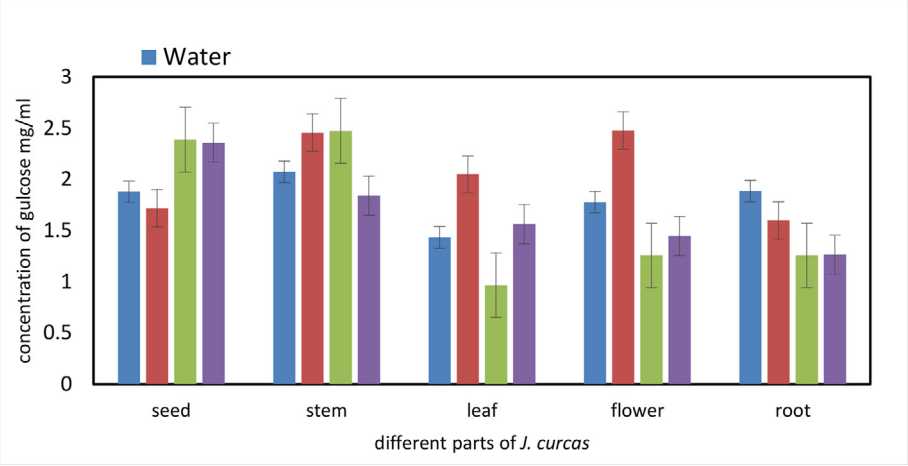

Fig. 5. Quantification of Total sugar from different segment extracts of *J. curcas*.

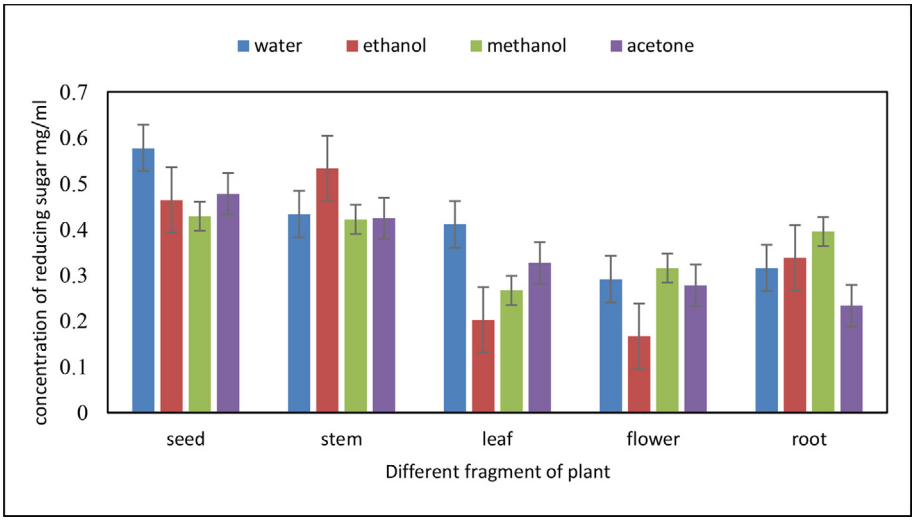

Fig. 6. Quantification of reducing sugar in different segment extract *of J. curcas*.

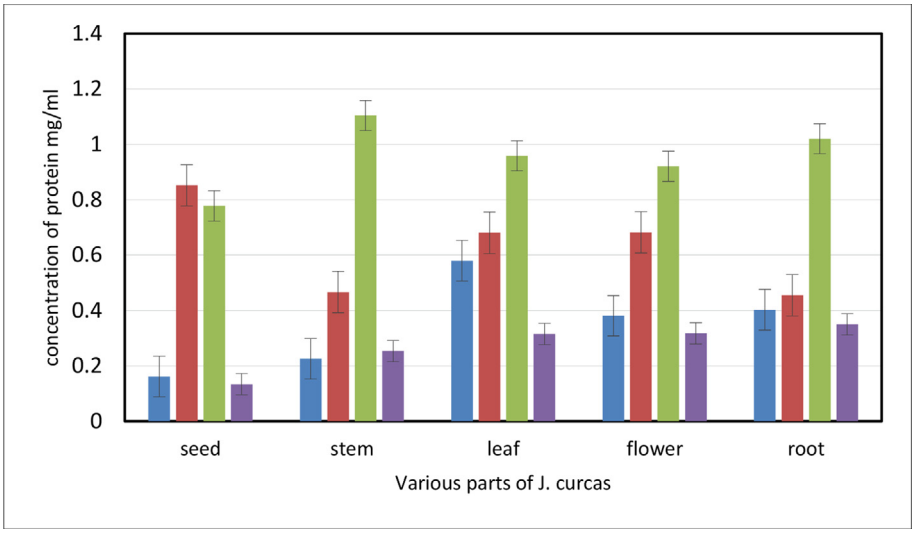

Fig. 7. Quantification of Total Protein in different extract of *J. curcas*.

extracts of root, flower and leaf as well as water extract of seed and stem.

4. Discussion

In the current study, different plant parts (Root, seed, stem, leaf, and flower) extract in various organic solvents were used to investigate the antimicrobial activity present in *Jatropha curcas.* Some phytochemicals compounds were also analyzed and correlated to each other. Antibacterial activity from different segments (Root, seed, stem, leaf, and flower) (Kissebah et al., 1982). Furthermore, water, hexane, methanol and ethyl acetate extracts were prepared from *Jatropha* latex to check antibacterial activity against different bacterial human pathogens such as *Salmonella typhi, Klebsiella pneumoniae,* and *Escherichia coli* (Suhaili et al., 2011). This study explores that the highest antibacterial activity was measured against *E. coli* (35.5 ± 3.53 mm) and inhibition zone against *Agrobacterium tumifaciens* in water extract root sample (25 ± 0.0). In ethanol extract of J. curcas, stem inhibited the growth of *K. pneumonia* (40 ± 0.0 mm) as compared other extract [Table 1]. The growth of *Enterobacter cloacae* ceased by ethanol extract of *J. curcas* seed and inhibition zone was measured 25.5 ± 0.707 mm. whilst, the methanol root extract also stopped the growth of *Proteous vulgar* (25.5 ± 0.707). Water extract of flower showed (21.5 ± 2.12 m m) inhibition zone against *S. Typimuruim*. The *J. curcas* has great potential as an antibacterial agent and cure of various human pathogens [Table 2].

In vitro antimicrobial activity against standard strains microorganisms and clinical isolates from hexane, ethyl acetate, methanol, and water methanol extracts *J. curcas* stem and leaf were tested against most food pathogens. The minimum bactericidal concentration (MBC) for in-vitro antifungal activity of all extracts showed considerable antifungal activity with different fungal species. (Ekundayo et al., 2011). It is suggested that different parts of *J. curcas* have excellent potential for two pathogenic fungal species *A. niger* and *P. notatum*. The maximum antifungal activity was examined in ethanol extract of flower and methanol extract of root 38. 5 ± 0.7 mm and 27.25 ± 0.35 mm respectively [Table 3]. While, the antifungal activity also measured with same reported method against various pathogens from ethanolic extracts of leaf and bark of *J. curcas (*Dada et al., 2014*)*.

The presence of some secondary metabolites like tannins, alkaloids, sterols, glycosides, saponins, terpenes and flavonoids are revealed of the extract and latex of Phytochemicals analysis (Arekemase et al., 2011, Olabinri et al., 2014). Cardiac glycosides are secondary phytochemicals constituents that have been used conventionally for the purpose to cure diseases such as congestive heart failure and arrhythmias(ÇiFtçi and Aydin 2018). In water solutions, Saponins produce a stable foam (soap), therefore saponins used to cure against chronic diseases as an antiviral and antifungal agent as it also plays very important role to protect from cancer and some other diseases (Havlík et al., 2012). Terpenoids are known as antioxidant agent that play key role in conventional and modern medicine to cure inflammatory diseases and also for cancer (Dillard and German 2000). Quinone also play key role in the metabolic process aerobically and has great potential against cancer (Deller et al., 2008). Coumarin is used in cosmetic industries to produce different cosmetic products. Furthermore, it is also used in different medicine for treating oedmas, but coumarins isn't added in foods (Ayinde et al., 2007). The existing literature shows that there are too many studies in the field of the potential medicinal use of *J. curcas* but its antimicrobial and phytochemical effects are still lacking. Therefore, this study has been taken as an important issue to address the research gap.

5. Conclusion

The study was intended to explore the antimicrobial and phytochemicals value of *J. curcas* extract and results revealed that the highest activity was measured against *E. coli*, *Agrobacterium tumifaciens, Klebsiella pneumonia, Salmonella Typimuruim, Enterobacter cloacae* and *Proteous vulgar* with different organic extracts. The study suggested that different parts of *J. curcas* have excellent potential against Gram-negative bacteria species and also two pathogenic fungal species *Aspergillus niger* and *Pencillium notatum*. Phytochemicals compounds were also analyzed and observed in significant amount both in qualitatively and quantitatively from different plant parts of *J. curcas* such as total phenolic compound, Alkaloids, Cardiac glycoside, Flavonoids, Saponins, Tannins, Terpenoids, Quinone and Coumarin. It was also observed that different parts are rich source of some important biomolecules such as total sugar (reducing & non reducing sugar) and proteins. This study recommends further on *J. curcas* suitability on green fuel production or biodiesel production, management of climate change, feed resources and animal nutrition as well as germplasm diversity, national development and rural sociology.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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